Great Dane Natural-Inspired Search Algorithm

A.Albert Alexe[1*], F. Sagayaraj francis[2], and R. Subramanian[3]

[1] Research Scholar, Department of Computer Science, Pondicherry University, India
[2] Professor, Department of Computer Science and Engineering, Puducherry Technological University
[3] Professor, Department of Computer Science, Pondicherry University
[*] Corresponding author. E-mail: albertalex@outlook.com

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The naturally inspired algorithm plays an important role in solving optimization problem. Naturally, inspired algorithm is used to search the optimized result from the large dataset. Many algorithms have been proposed already to solve the complex problem and result was proved. In this paper, we propose a new algorithm called Great Dane natural inspired search algorithm. This algorithm inspires the behaviour of pet animal Great Dane dog. The behaviour of Great Dane is very strong to protect the home. The behaviour of Great Dane is used to find the optimal solution from the large data base. The proposed algorithm is used to solve the single and multi-variable cost function problems through the generation of binary and integer structured Great Dane. The Great Dane algorithm is tested and implemented using De-Jong Type I function and the results provide the performance of the algorithm is better than the other evolutionary algorithms.

Keywords: Great Dane algorithm, Home defence, Home takeover, mating

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1. Introduction

More the problem becomes complex in engineering the tougher it becomes to obtain the solutions. To overcome this drawback of complexity and make it simpler we depend upon the nature behaviours to provide solution. The bio inspired algorithm (BIA) is derived and inspired by nature. The field of BIA is providing the more opportunities for the researchers to do the research. The creation of BIA is a very challenging task for researchers. The BIA is mainly used for solving the optimization problem. Many bio-inspired algorithms were developed and proved for solving many complex problems. Basically, the bio-inspired algorithm heavily depends on three fields like biology, computer science and mathematics. Studying about the behaviour of nature, leads to the development of new real time application like, travelling salesman problem and NP complete problem. The BIA plays a very important role in solving many optimization problems, where more complex the problem becomes the more complex the solution is evaluated. In order to solve this problem in a simpler manner we derive the solutions from nature. The Bio –inspired algorithm can be divided into two parts such as genetic algorithm and evolutionary algorithm. The genetic algorithm was developed by Holland in 1975 and inspired by Darwin theory of "survival of fittest [1]. The working procedure of a genetic algorithm is based on population based stochastic optimization algorithm. The selection of new population is based on selection, crossover, mutation and accepting the solutions.

Bio-inspired algorithms are self-adaptive and fault-tolerant behaviours that help to boost the autonomous nature of any systems and are proving effective for the solution of all the complex problems. This is called evolutionary algorithm (EA). EA is a sub-field of bio-inspired algorithm and derived using natural behaviour. In other cases, solutions rely on the operations of agents, whose behaviour is inspired by biological systems, including ant colonies, bird flocks, honey bees, bacteria, and many more.

In such systems, "swarm intelligence" emerges from the interaction of a large number of very simple agents.

A bio-inspired algorithm is routinely applied to hard and large problems in a variety of areas. Some examples are optimization problems solved, with genetic algorithms, resource discovery and data mining computations in Grid, Cloud and P2P frameworks, achieved by ant-inspired algorithms, routing strategies inspired by the honey bee behaviour, and so on. Some of the developed BIA are ant colony optimization, bee colony algorithm, lion algorithms and bats algorithms and many more algorithms have been used widely in many applications where each algorithm tend to produce a better solution for that particular application .In this paper, the social behaviour of a particular dog breed called great is analysed where its protecting behaviour and mating behaviour is discussed and this nature behaviour is developed into a Great Dane inspired algorithm.

The remainder of the paper organized as follows. In section 2, we summarize about the various types of algorithm inspired naturally. We explore and propose a novel naturally inspired bio-inspired algorithm called Great Dane natural inspired algorithm in section 3. In section4, the simulation results of the proposed algorithm are presented and finally the paper is concluded in section 5.

2. Related Work

Ant colony optimization (ACO) is a general purpose swarm intelligence algorithm used to solve many complex problems very efficiently. The ACO was originally developed by Marco Dorigo et al [2]. The aim of this algorithm is to provide the minimum distance between source and destination. The ants are using trails to identify the shortest path between the source and destination. The lion's algorithm was originally proposed by B.R. Raj Kumar et al [3] is used to find the optimized result from the large data based. The algorithm was developed using the behaviour of lions. The interpretation of such social behaviour to algorithmic perspective helps in searching out highly optimal solution for a large solution space.

The Multi-Objective Flower Algorithm (MOFA) was originally developed by Xin-She Yang et al [4]. MOFA derived the characteristics of flowering plants. The bio-inspired algorithm plays a vital role in solving complex optimization problem. The Dynamic array bat algorithm (DABA) was proposed using the behaviour of Bat echo system. DABA is inspired from bats echo system and how they use it in prey finding. Sureshkumar Sudabattula et al [5] proposed a flower pollination algorithm, where the performance of the distributed system is increased by the pollination behaviour in flowers. Haruna Chiroma et al [6] proposed a new approach in the flower pollination process which can be used for forecasting applications the reproduction capability and the global pollination behaviour of flowers in plants are mapped to the forecasting problems. Yang [7] proposes a flower pollination algorithm for global optimization where the different types of pollination are discussed and the performance of the algorithm is analysed.

Yu-Peng Chen et al [8] propose a novel optimization algorithm with the foraging behaviour of the bacteria where the behaviour of E coli bacteria is analysed with respect to four types of motion such as chemo taxis, swarming, and reproduction and elimination dispersal. The bacteria tumbles at the initial stage where it forages its movement in one of the above four types. Guang-Yu Zhu Et al [9] propose a new optimal foraging algorithm, which is inspired from the animal behavioural ecology theory optimal foraging theory where the objective function is denoted with respect to the animal position of the animal in the patch.

Sakkayaphop Pravesji [10] propose a hybrid bat inspired algorithm by analysing the natural behaviour of bats based on the echolocation behaviour of micro-bats with varying pulse rates of emission and loudness. This behaviour is applied in solving the continuous optimization problem. Ilyes Khennak et al [11] developed a medical retrieval system with the bat inspired algorithm where a query can be expanded and used. Najmeh Sadat Jaddi et al [12] propose a modified bat inspired algorithm which is used for optimization in neural network model. The local search behaviour of the bats is modified and different parameters are introduced. Vassilios I. Skoullis et al [13] propose a hybrid cat swarm optimization algorithm by using the food seeking behaviour of the cat within the selected search space is mapped to a school time table solving problem. The cat first searches for the particular are for food after identifying the location it consumes its food. Shu-Chuan Chu et al [14] proposed the cat swarm optimization algorithm using the behaviour of cats are modelled into sub models. The inactive behaviour of cats are identified with respect to user defined parameters.

Tian-qi WU et al [15] propose a dolphin swarm algorithm with the biological behaviour of the dolphins such as echolocation, exchange of information and division of labours are analysed and proposed with four vital living habits thus it tends to reduce the convergence problems. Saeed Gholizadeh et al [16] propose an improved dolphin algorithm where the echolocation is increased and identified easily. Kavesh et al [17] propose a new optimization algorithm with the dolphin echo location characteristics

where the searching location can be easily identified K Hui Wang et al [18] propose a firefly algorithm with the social behaviour of fireflies where each fire fly can be attracted to another fly with respect to the brightness property. Lifang He et al [19] proposes a modified firefly algorithm which can be used with the light intensity factor and mapped to colouring space approach. Homa Amirian et al [20] propose a frog leaping algorithm for selection of scheduling task where the shuffled motion behaviour of frog is analysed. Bhattacharjee et al [21] proposed a shuffled frog leaping algorithm which is modified with the leaping behaviour and tuned parameter. M. T. Vakil Baghmisheh et al [22] propose a discrete shuffled frog leaping algorithm where the number of parameters are increased and shuffled it with low and high variable functions.Seyedali Mirjalili et al [23] propose a Meta heuristic grey wolf optimizer algorithm in which the leadership and hunting characteristics of grey wolf with its types such as alpha, beta, delta and omega are analysed. Mehak Kohli et al [24] propose a chaotic grey wolf optimization algorithm this algorithm is improved to increase its performance in global convergence speed rate. Moumita Pradhan et al [25] propose an oppositional grey wolf optimization (OGWO) algorithm where the social hunting behaviour is analysed.

Manizheh Ghaemi et al [26] propose a forest optimization algorithm in which the behaviour of few trees in forest which can survive for more number of decades is captivated. The seeds, growth of trees and the animal interaction with them are kept as parameters and discussed under different scenarios. Manizheh Ghaemi et al [27] propose a forest optimization algorithm for feature selection. The relevant and irrelevant features are to be added and removed with the functional behaviours of tree. Najmeh Sadat Jaddi et al [28] propose a kidney inspired algorithm where the waste solutions are excreted from the kidney is studied and that behaviour is captured. The filtered rate and objective function is calculated and verified. Peifeng Niu et al [29] propose an ameliorated krill herd algorithm with the convergence speed of the global process can be increased with respect to the foraging behaviour of the krill herd. Asaju La'aro Bolaji et al [30] propose a comphrensive review of the different behaviours analysed in krill herd and the nature inspired algorithm. The convergence property of the krill herd and its rate are represented. Gaige Wang et al [31] propose a novel krill herd algorithm for global numerical optimization where the mutation scheme is used for the convergence speed.

M.K. Marichelvam et al [32] propose a hybrid monkey search algorithm where it generates a two sub population and two objective functions. The position of the monkey is identified and the climbing position and distance are calculated. The time taken to cover the distance and speed are generated. Kavita Gupta et al [33] propose a spider monkey optimization algorithm where the series of behaviour is calculated till the target is obtained. It is used in constrained optimization problems. Avinash Sharma et al [34] propose an Ageist Spider Monkey Optimization algorithm where the spider monkey group consists of monkeys of all age groups. The ageist monkey consists of the excluded population in age group of the monkey in behaviours is calculated. Yunzhi Jiang et al [35] proposed a honey bee mating algorithm using the behaviour of queen, drone and workers bees. Patcharawadee Poolsamran et al [36] proposed a modified marriage in honey bee optimization function by which the objective function is modified with respect to the queens function after the mating process.

3. Great Dane Algorithm

3.1. Great Dane Social behaviour

The Great Dane is a pet animal in almost all the home. It has the interesting behaviour capability. The appearance of Great Dane portrays itself as a large animal. The people get frightened by seeing its massive appearance even labour dog also. The pet Great Dane is used to protect the home from labour dog as well as a thief. The female mate pets are attending the mating with male and give the offspring. Crossover is possible if the Great Dane pet is mating with labour dog. The puppy needs only 2-3 years to attain the sexual maturity, so the male Great Dane needs to protect the puppy for same years. Meanwhile, in 2-3 years, the labour dog tries to defect the pet great done to capture the puppy as well as territorial place. The labour dog always tries to defeat the pet dog. If the labour dog defeat the pet Great Dane, then the labour dog proud enters the territorial home place immediately. The labour dog forces the female dog to estrus and copulates for its offspring.

Nomenclature		
x_i	-	Variable of i^{th} solution
$x_{i^{min}}$	-	Minimum limit of solution space
$x_{i^{max}}$	-	Maximum limit of solution space
x^m	-	male greatdane
x^{fm}	-	female greatdane
L	-	Solution length
x^{puppy}	-	puppy of x^m and x^{fm}
x^{m_puppy}	-	male group of puppy
x^{fm_puppy}	-	female group of puppy

3.2. Great Dane algorithm:

The Great Dane dog algorithm searches for the optimal solution for larger data space based on two behaviours, home defence and home takeover. The home defence is carried out between Great Dane and labour dog. The home takeover is carried out between old pet Great Dane and newly entered labour dog.

Scenario 1: The solution of the Great Dane is to be determined and the puppy solution is derived from existing solution.

Scenario 2: Home defence is a process of evaluating between existing solution (pet Great Dane) and newly derived solution by labour dog. The newly derived solution is optimized and if the new solution is better than old solution, the old solution is replaced by newly derived solution.

Scenario 3: Home takeover is a process of taking the control of pet Great Dane. The labour dog becomes new pride for the home or territorial. The newly derived solution will be taken from the old solution vanished from the territorial. Selection operation is performed to keep better solution and destroy the old solution.

The proposed structure of the Great Dane algorithm is given in Fig. 1.

The proposed structure of the Great Dane algorithm is based on five important steps: i) Generation of territorial pet ii) Deal with mating iii) Process of defending home iv) Home takeover and last v) Food searching behaviour of Great Dane.Great Dane dog searching algorithm procedure:

The main objective of the algorithm is to find the minimum or maximize the objective function. Consider the following as objective function

$$\underset{x_i \varepsilon (x^{min}, x^{max})}{\arg\min} \quad f(x1, x2, \cdots xn) \quad n > 1 \tag{1}$$

The given eqn. (1) Describe the details about the objective function. The value of $x_i 1, 2 \cdots$ n. where n=1. The great Dane pet has to be a binary structure and n should be greater than 1. The great Dane has to go with the integer structure. As from the Fig. 1, the search procedure is started with the territorial pet generation followed by mating, home defence, home takeover and finally end with food searching behaviour. The male great Dane dog is denoted by cm and female great Dane dog is represented by Xfm. The initial great Dane pride is denoted by x^m and x^{fm}. In general, a wide number of male and female great Dane dog are available and the number of male great Dane or solution length of male Great Dane is defined by (2)

$$x^m = [x_1^m, x_2^m, x_3^m, \cdots x_L^m] \tag{2}$$

The number of female great dane or solution length of male great Dane is defined by equation 3

$$x^{fm} = [x_1^{fm}, x_2^{fm}, x_3^{fm}, \cdots x_L^{fm}] \tag{3}$$

L is called the length of the solution space.

$$\begin{bmatrix} n; & n > 1 \\ m; & \text{others} \end{bmatrix} \tag{4}$$

From the Eq.2, x_k^m and x_k^{fm}, where l is the length same length of solution vector length, k=1, 2,$\cdots$, L. The interval of the arbitrary integer generated between x_k^{min} and x_k^{max} then the value of n>1.

If n = 1, the value of x_k^m and x_k^{fm} is either 0 or 1. The value of g (x_k) ε (x^{min} and x^{max}). The value of g (xk) is defined by equation (5)

$$g(x_k) = d(x_1) \sum_{k=2}^{L} 2^{L-1} x_k \tag{5}$$

$$d(x_k) = \begin{bmatrix} 1; & if x_1 = 0 \\ -1; & \text{otherwise} \end{bmatrix} \tag{6}$$

3.3. Crossover and Mutation

Crossover and Mutation are basic two operations of genetic algorithm (GA). The crossover and mutation operation are done by binary encoding. The performance of the algorithm depends on both crossover and Mutation efficiency only. There are many ways to do the crossover operation. In this paper, we follow the single point crossover method for offspring generations. Single point crossover-one crossover point is selected, binary string from the beginning of chromosome to the crossover point is copied from one parent, the rest is copied from the second parent . The crossover schematic view is illustrated in Fig. 2.

Grouping the pets using the clustering method. Here we are using k-Means algorithm is used for clustering male and female Great Dane. In generally, the puppy pool have the combination of both x^m and x^{fm} puppy's. The challenging part of clustering is dividing the male and female puppies in equal numbers. The maintenance of equal number is a challenging task. If the numbers are not equal, the weak puppies are identified and the necessary action is taken. So the health of the pool is maintained equally. The week puppy is moving out from the pool for maintaining the health. To maintain the health of the pool is very important to calculate the objective function. If the x^m and x^{fm} puppies are healthier, then the solutions of the puppies are added to existing solution of the pool. So the solution of the pool gets updated.

In general, the value of the objective function is initialized with 1. If the cubs or puppy's added to the pool, then the pride value will be incremented by 1. So we easily identified the strength of the cluster.

Step 1 : Territorial Pet generation
1.1: generate Great Dane male and female solution
Step 2 : Mating
2.1: Crossover
2.2: Mutation
2.3: Gender grouping
2.4: Choose new territorial dog
Step 3 : Home Defence
3.1: Manage the puppy age
3.2 Protect the territory
Step 4 : Home Takeover
4.1: Selection of strongest dog
Step 5 : Food searching
5.1: Shortest path to find the food

Fig. 1. Structure of Great Dane Algorithm.

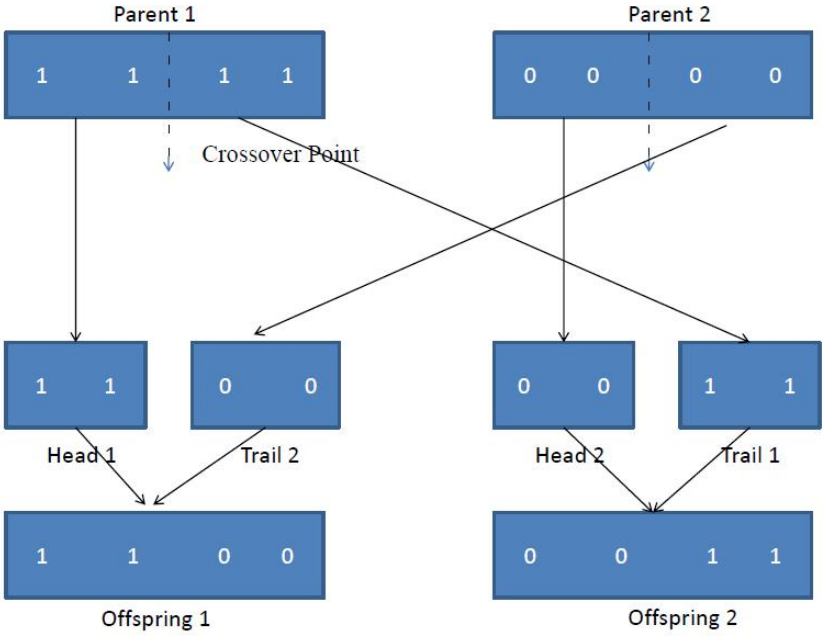

Fig. 2. Crossover Operation.

4. Experimental Result

The proposed Great Dane algorithm is simulated and tested in SCILAB 5.4.0 by using simple benchmark function called De-Jong Type I function.

De-Jong Function I Specification

$$f_1(x) = \sum_{i=1}^{n} x_i^2 \quad -5.12 \leq x_i \leq 5.12$$

f1(x)=sum(x(i)$\hat{}$2), i=1:n, -5.12<=x(i)<=5.12.

The global minimum Value defined as:

f(x)=0, x(i)=0, i=1:n

The experimental results are shown in the next page in Figs. 4, 5 and 6.

$$f_1(x) = \sum_{i=1}^{n} x_i^2$$

The Sphere model of De-Jong Function serves as a test case for all convergence velocity and also well known and widely used in all fields of bio inspired algorithm occurring in the test sets of De Jong, Schwefel and Fogel [37, 38].

The performance of the algorithm is validated with the size of the solution space is highly varied where the bench mark De-Jong Type I function is used in the implementation

```
Initialize  < - 1        # Initialize  the Population
Do
        Generate X^m and X^fm
If ( f(X labour dog) < f( X pride))
        If  (f(X^puppy) > f(X fm_puppy))
                If (f( X m) > (X fm )|| (X^m )< (X^fm))
        Kill/  Move out from the pool
                X m and X fm
else
Go to
                Mating
End if
        Increment by 1
```

Fig. 3. Code for Home Defence.

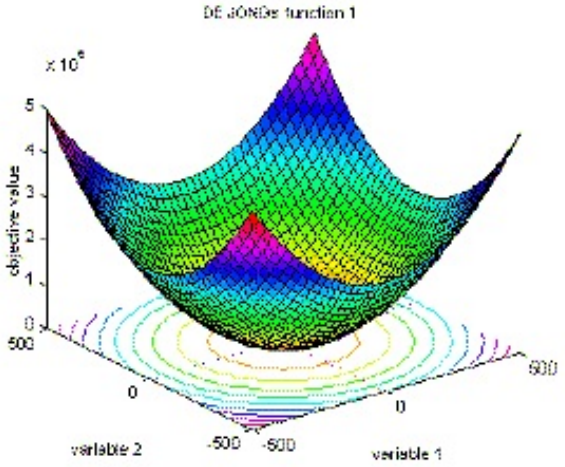

Fig. 4. Visualization of De-Jong Function.

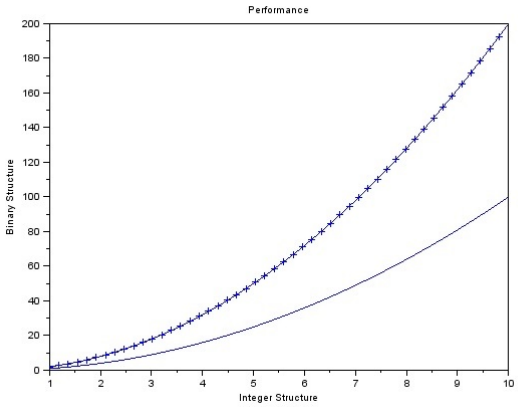

Fig. 5. convergence of regions.

for plotting the convergence graphs in general evolutionary programming. The Fig. 4 illustrates the De-Jong Type I Function which represents the visualization of De-Jong function

The testing parameters taken for the Great Dane inspired algorithm are illustrated in table 1.The parameters satisfy the objective function criteria the global variable is initialized with the initial value 0 until where the condition is satisfied for the value n the function is executed when the value exceeds the condition is terminated and the end result value is obtained. Figs. 5 and 6 illustrates the convergence graph plotted after results are obtained. The regions are clearly distinguished and marked with the tested parameters.

Table 1. Algorithmic parameters for Experimental Validation.

S.No	Algorithmic Parameters
1	N
2	x^m
3	x^{fm}
4	x^{puppy}
5	Crossover probabilities
6	Mutation probabilities

The above table 1 shows the algorithmic parameters taken for the validation of the Great Dane inspired algo-

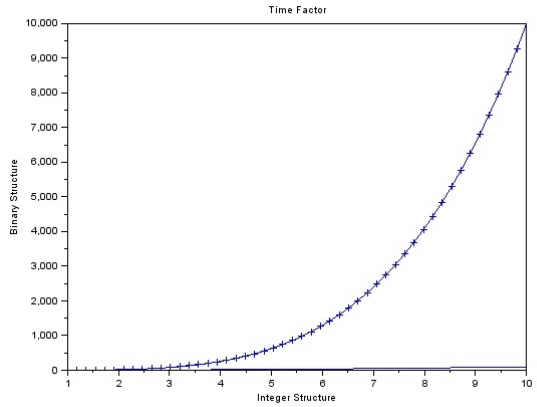

Fig. 6. Convergence plotted regions.

rithm which is evaluated under the bench mark De Jong Type –I function. The convergence graphs are plotted within this solution space evaluating the above parameters of the algorithm.

5. Conclusions

In this paper, a novel searching algorithm inspired from the social behaviour of Great Dane Dogs called Great Dane inspired algorithm was proposed and the performance is compared with the general evolutionary programming. The Great Dane inspired algorithm is evaluated with different solution space sizes with predefined algorithmic parameters. From the analysis of the algorithm it is concluded that the Great Dane inspired algorithm is monitored and maintained with stable and reliable performance, where the convergence of the respective regions can be identified with the optimal solution. The total cost function is minimized with the size of the solution space. The above results show that the performance of the algorithm is promising under the benchmark of De-Jong Type-I function. In Future, the Great Dane inspired algorithm can be improved efficiently to reduce the time complexity. This algorithm will be to be implemented for cervical cancer image detection where the regions of cancer cells can be identified easily with the identification of nucleus and cytoplasm regions with the behaviours of Great Dane Dogs.

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